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Economic Insights

# Industrial Contributions to Research and Development Spending in Canada

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. not available for any reference period
.. not available for a specific reference period
... not applicable
0 true zero or a value rounded to zero
$0^s$ value rounded to 0 (zero) where there is a meaningful distinction between true zero and the value that was rounded
$^p$ preliminary
$^r$ revised
x suppressed to meet the confidentiality requirements of the *Statistics Act*
$^E$ use with caution
F too unreliable to be published
* significantly different from reference category ($p < 0.05$)

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# Industrial Contributions to Research and Development Spending in Canada

*by Elizabeth Richards, Charlene Lonmo and Guy Gellatly*
*Analytical Studies Branch and Investment, Science and Technology Division*

This *Economic Insights* article highlights notable changes in the pace and composition of industrial research and development (R&D) spending in Canada during the 2000-to-2013 period. The analysis is based on historical time series data that conclude with the publication of estimates for reference year 2013.

New data on industrial R&D will be released in the coming months. These new survey results begin with estimates for reference year 2014 and reflect conceptual and methodological changes designed to enhance the scope and relevance of the program. Following the introduction of these changes, a study on the break in the time series will be conducted later in 2017.

This article highlights trends in industrial R&D spending in advance of the upcoming release of the new data. The analysis underscores the extent to which support for higher R&D spending in more recent years has come from resource-based companies.

## Overview

The contributions of different industrial sectors to overall changes in research and development (R&D) spending in Canada have shifted markedly since the technology boom of the late 1990s. During that period, much of the annual growth in business sector R&D reflected higher in-house expenditures by technology-based manufacturers specializing in information and communications products. By the mid-2000s, service-based firms (companies that provided specialized R&D services, wholesaling services and information management services) were making sizable contributions to the growth in industrial R&D. More recently, much of the support for increased industrial R&D spending in Canada has come from resource-based companies engaged in oil and gas extraction.[1]

This article highlights recent changes in the pace and composition of industrial R&D spending.[2] Using data on in-house R&D expenditures by province and industry, it reports on the net contributions that firms in different economic sectors have made to changes in R&D spending at the national level. These industry contributions are calculated over three separate periods, to highlight differences in the composition of R&D spending prior, during, and subsequent to the 2008-2009 recession. Data for recent years underscore the extent to which western resource-based companies contributed to overall industrial R&D spending.

## Annual R&D spending in 2013 below pre-recession levels

In 2013, annual in-house R&D expenditures by business enterprises remained below levels reported prior to the 2008-2009 recession.[3] In 2013, businesses spent $16.0 billion on R&D, compared to $16.8 billion in 2007 (Chart 1).[4] From 2007 to 2013, Canada's ratio of business enterprise expenditure on research and development (BERD) to gross domestic product (GDP) trended lower, from 1.06% to 0.85%. In comparison, the overall BERD-to-GDP ratio for Organisation for Economic Co-operation and Development countries rose from 1.53% to 1.61% during the same period.[5] These recent declines reflect lower spending by many traditional sources of industrial R&D, particularly Ontario's manufacturing sector. These spending reductions coincided with sizeable reductions in R&D personnel. Total R&D employment declined 21.1% from 2007 to 2013, as the number of technicians and technologists employed in manufacturing and services fell markedly.

The contributions of different industries to overall changes in R&D spending shifted over the last decade. During the mid-2000s, many industrial sectors increased their in-house expenditures on R&D.[6] Annual expenditures in 2007 were $2.7 billion larger than in 2003, as higher spending by service-based firms, resource-based companies and manufacturers all

1. For the purpose of this article, the term resource-based companies refers to enterprises engaged in mining, quarrying, and oil and gas extraction, while the term energy companies refers to enterprises engaged in oil and gas extraction, contract drilling and related services.
2. The R&D data used in this article reflect in-house expenditures by business enterprises; they do not include expenditures related to R&D in the social sciences or humanities.
3. At the time of publication, 2013 is the latest year available for estimates on industrial R&D expenditures by province. Intentions data are available for Canada for 2014 and 2015.
4. All data are reported in current dollars unless otherwise noted.
5. See the *Main Science and Technology Indicators* (OECD, accessed on November 4, 2016).
6. The "Total all industries" category at the bottom of Chart 2 represents the cumulative change in annual R&D expenditures over each of these periods.

contributed to gains at the national level (Chart 2). Following five consecutive annual gains, in-house R&D expenditures in 2007 were 17.5% higher than in 2001, when in-house expenditures among manufacturers were at their peak.[7]

Total in-house spending on industrial R&D declined from 2008 to 2010. Annual expenditures in 2010, even as the economy recovered after the 2008-2009 recession, were about $1 billion lower than in 2007. While firms that provided scientific R&D services, wholesalers, and resource-based companies increased spending during this period, in-house R&D spending by manufacturers in 2010 was $1.1 billion lower than in 2007.

In more recent years, in-house spending by manufacturers continued to decline, while R&D spending among resource-based companies, led by oil and gas producers, increased. Total in-house expenditures by businesses in 2013 were $229 million higher than in 2010, an increase of 1.4%. By contrast, the real output of business-sector industries expanded by over 9% over this three-year period.

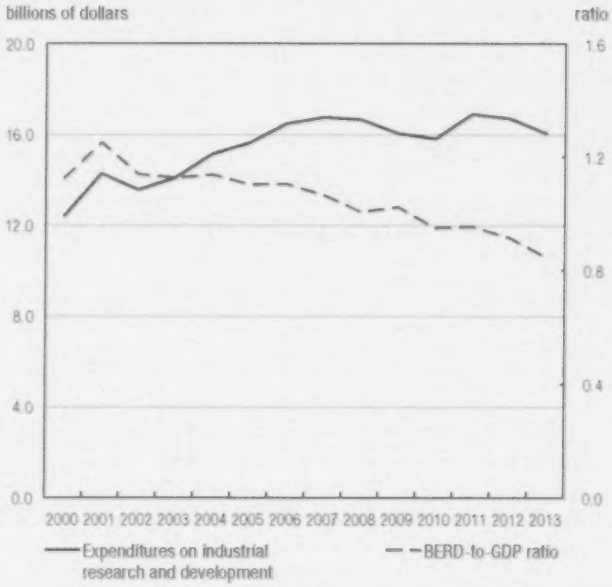
## More R&D spending in energy companies as capital investments supported economic growth

Businesses operating in the resource sector increased their in-house R&D expenditures after the 2008-2009 recession, as capital outlays by energy companies on engineering assets and machinery and equipment supported Canada's economic recovery.[8] In 2013, annual in-house R&D expenditures by companies engaged in mining, quarrying or oil and gas extraction were $1.6 billion, up 61.6% from 2010, and about twice the amount spent on in-house R&D in 2007. Higher in-house R&D in oil and gas extraction accounted for over 80% of the growth in resource-based R&D from 2010 to 2013 (Chart 3), with in-house expenditures aimed at developing and supporting new technologies related to heavy crude extraction and environmental remediation. These in-house expenditures of energy companies are more capital-intensive than those of many other R&D-performing sectors, as only about 10% of total R&D spending in energy companies is used to pay the wages and salaries of R&D personnel.[9]

Most of the net growth in resource-sector R&D following the 2008-2009 recession was due to higher spending in Alberta. Annual in-house expenditures by the province's oil and gas producers more than doubled between 2010 and 2012, increasing from $500 million to $1.4 billion. During this period, energy companies were ramping up capital spending and extraction activity, following notable declines during the 2008-2009 recession.

The growth in resource-based in-house R&D in Alberta following the recession coincided with large increases in capital spending by energy companies. Higher outlays on structural assets and machinery and equipment in Alberta, supported by engineering construction on oil sands projects, accounted for almost half of the total increase in non-residential capital spending from 2010 to 2012 for Canada.[10] Higher spending on capital assets coincided with notable output gains in Alberta's energy sector. From 2010 to 2012, Alberta's oil and gas producers expanded output by 6.7% supported by increases in heavy oil extraction and upgrading.[11]

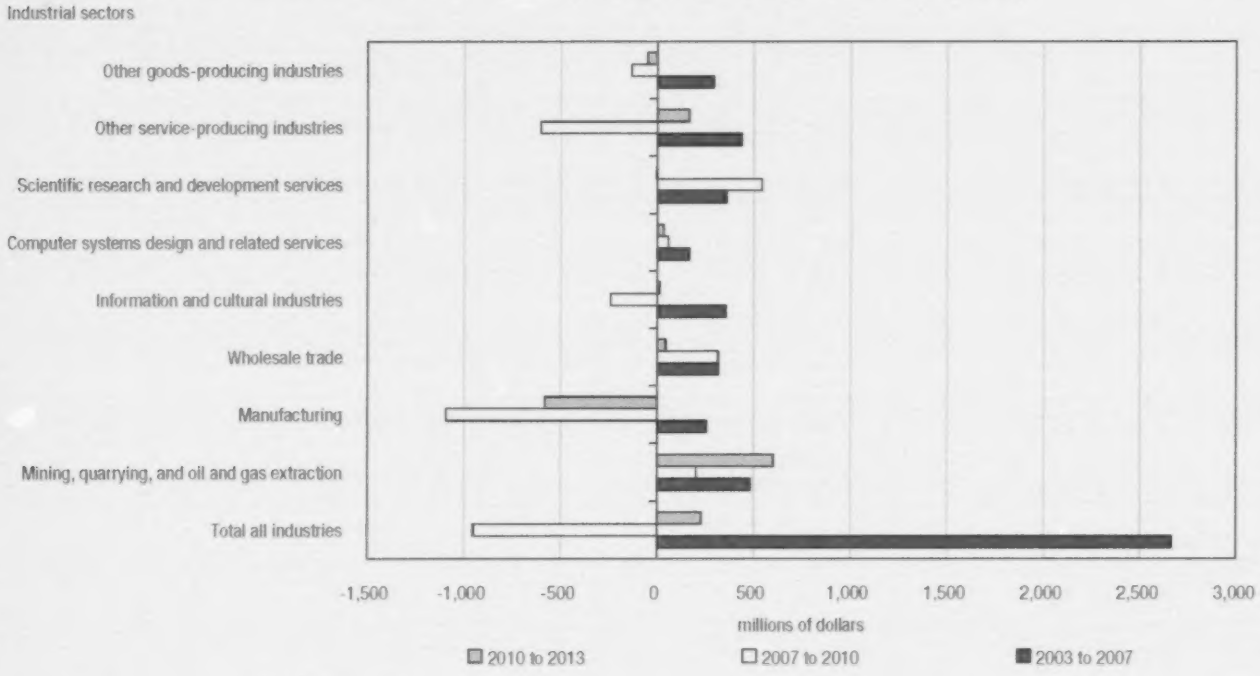
**Chart 1**
**Expenditures on industrial research and development and BERD-to-GDP ratio**




**Note:** BERD: business enterprise research and development; GDP: gross domestic product.
**Sources:** Statistics Canada, CANSIM table 358-0024; and OECD, n.d., *Main Science and Technology Indicators*, accessed from stats.oecd.org on November 4, 2016.

7. R&D spending for the manufacturing sector peaked in 2001, and then contracted sharply in 2002 on lower spending by communications equipment manufacturers. Total expenditures on industrial R&D peaked again in 2007, prior to the 2008-2009 recession.
8. For analysis of recent trends in current dollar capital spending, see Bloskie, Gaudreault, and Gellatly (2013) and Gaudreault, Gellatly and Bloskie (2015). For annual estimates of the contribution of business investment to economic growth, see CANSIM table 380-0100 (Statistics Canada, n.d.a.).
9. Based on data for 2013.
10. These data on capital expenditures, collected from the annual Capital Repair and Expenditure Survey, include outlays on a broad range of construction and machinery and equipment assets. They do not include in-house expenditures on R&D.
11. Annual data on real GDP by province and industry are available from CANSIM table 379-0030 (Statistics Canada, n.d.b).

**Chart 2**
**Changes in expenditures on industrial research and development for Canada in selected industrial sectors**




**Sources:** Statistics Canada, CANSIM table 358-0024.

## Lower R&D spending by Ontario manufacturers contributed to recent declines

During the mid-2000s, the growth of in-house R&D spending by companies was supported in part by manufacturers of communications equipment, aerospace products and parts, semiconductors, pharmaceuticals and medicinal products. Industrial in-house R&D expenditures by manufacturers declined sharply in 2007 and 2008, and then generally trended downward from 2010 to 2013 as manufacturing output began to recover from lows during the recession (Chart 4). By 2013, total manufacturing in-house R&D was about 20% below 2007 levels on lower expenditures by firms that produce pharmaceutical products, semiconductors, and communications equipment. Steady in-house R&D spending by aerospace firms moderated the decline.

Much of the recent decline in manufacturing in-house R&D reflected lower spending by Ontario-based firms, as major sources of industrial R&D in the province, such as computer and electronic equipment manufacturers and pharmaceutical manufacturers, reduced their R&D activities (Chart 5). Lower in-house R&D spending in Ontario-based manufacturing reflected declines in the number of manufacturing firms performing R&D and operating in the province, and coincided with lower levels of capital spending and manufacturing output.

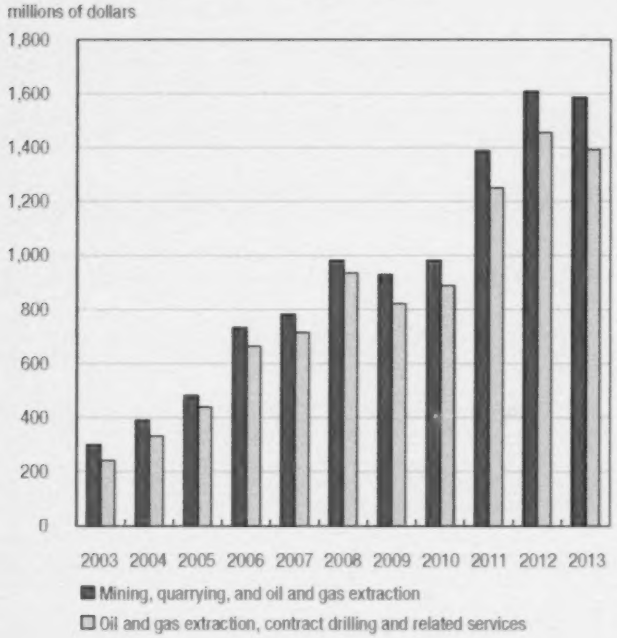
R&D spending, like other activities within Ontario's manufacturing sector, was substantially impacted by the 2008-2009 recession. Between 2007 and 2009, manufacturing output in the province fell by about 24% as motor vehicle and motor vehicle parts manufacturers, metal manufacturers and many other manufacturing industries scaled back production. By 2013, manufacturing output in Ontario was 15% lower than 2007 levels.

These declines coincided with a substantial amount of firm turnover within Ontario's manufacturing sector. From 2007 to 2013, firm exits outpaced entries, leading to a 5.0% decline in the size of the business population.[12] Over that period, the number of manufacturing firms performing R&D in Ontario declined by 31% to about 3,100 companies, with the bulk of the decline occurring after 2011. At the same time, annual capital spending by manufacturing industries in Ontario fell from $8.4 billion in 2007 to $4.8 billion in 2013.[13]

While R&D spending by Ontario-based manufacturers in 2013 was about 30% below 2007 levels, in-house R&D spending by

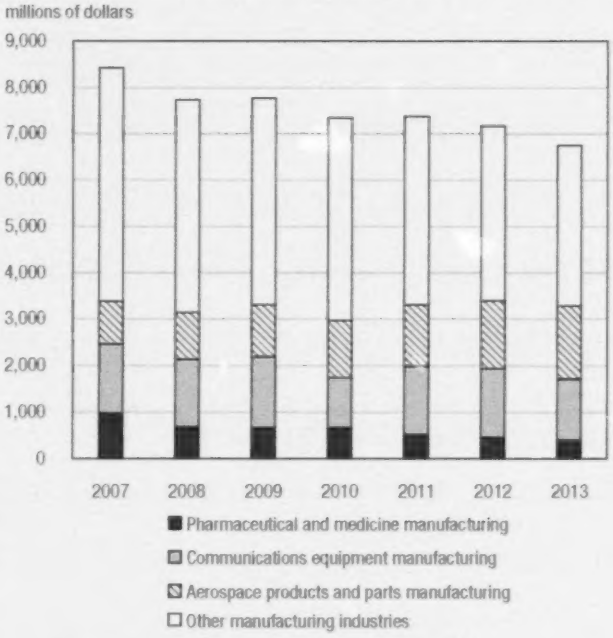
12. For data on business dynamics, see Statistics Canada CANSIM table 527-0007 (Statistics Canada, n.d.c). For an analysis of business entry and exit rates, see Macdonald (2014).
13. As noted earlier, data on capital expenditures exclude in-house spending on R&D. For information on longer-term structural changes in Ontario's economy since 2000, see Brown (2014).

**Chart 3**
**Expenditures on industrial research and development in mining, quarrying, and oil and gas extraction**




**Sources:** Statistics Canada, CANSIM table 358-0024.

**Chart 4**
**Expenditures on industrial research and development for Canada in selected manufacturing industries**




**Sources:** Statistics Canada, CANSIM table 358-0024.

Quebec-based manufacturers expanded by about 10% over this period, as steady increases by aerospace firms offset declines in other industries. This occurred despite declines in Quebec's manufacturing output. The real GDP of Quebec-based manufacturing was 11.3% lower in 2013 than in 2007, as many industries declined and the number of active businesses fell. By contrast, the output of Quebec's aerospace industry grew by 5.5% during this period.

## Scientific R&D services in Ontario mitigated declines in manufacturing

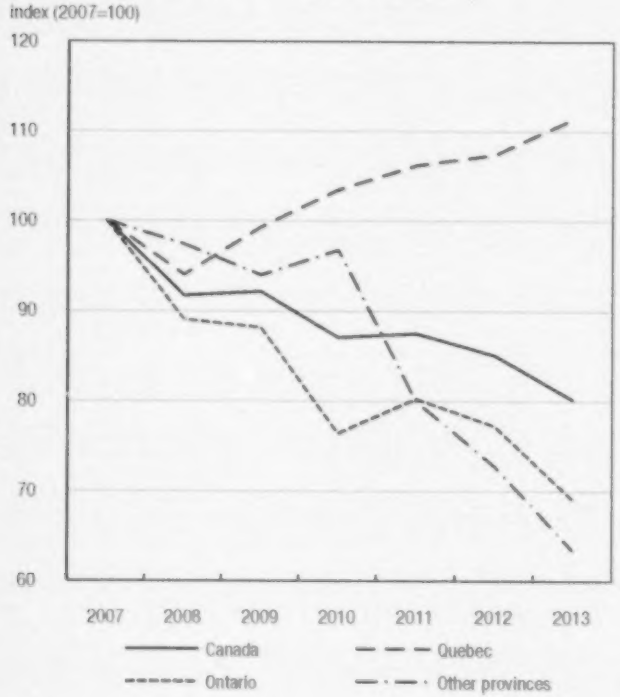
Led by gains in Ontario, in-house R&D spending by companies that provide scientific R&D services rose during the 2008-2009 recession (Chart 6).[14] These companies perform R&D in physical, engineering and life sciences. They can serve as support-centers for R&D in different industries and start-ups are often assigned to this industry before they develop marketable products (Council of Canadian Academies 2013, p.10).[15] In 2013, roughly half of in-house R&D spending in this industry was for the performing company's own use, one third of spending stemmed from foreign sources, while the remainder was contracted by government and other Canadian firms.[16] Spending by Ontario-based businesses that provided these services doubled from 2009 to 2011, before declining in more recent years. Despite this, overall R&D spending by these companies at the national level was about 40% higher in 2013 than in 2007, and Ontario-based companies were responsible for over half of this increase. These gains occurred even with a decrease in the number of firms performing R&D services.

## Oil and gas expansion shifted R&D spending westward

Increased R&D spending by resource-based companies, coupled with lower in-house R&D expenditures by manufacturers, has had a measurable impact on the overall geography of industrial R&D. In 2007, companies based in Ontario accounted for 48.1% of total R&D spending (Chart 7). By 2013, Ontario's share had declined to 43.7%, mainly reflecting declines in manufacturing. Higher in-house R&D expenditures by oil and gas companies in Alberta helped raise that province's share of total industrial R&D spending from 8.6% in 2007 to 12.5% in 2013. In Quebec,

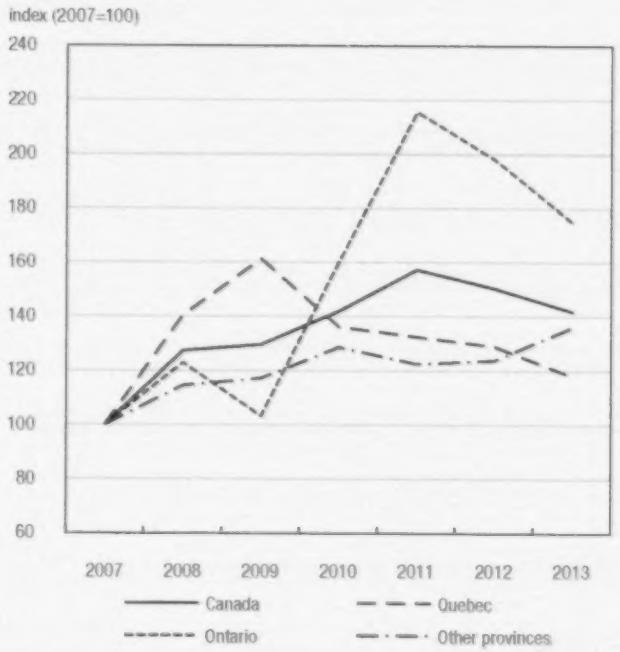
14. Data for R&D service firms may in part reflect in-house R&D spending by companies that were previously classified as manufacturers, but for whom manufacturing is no longer their principal economic activity.
15. For more information, please refer to the Council of Canadian Academies (2013) and Lonmo (2007).
16. For more information, please see *Industrial Research and Development: Intentions* (Statistics Canada 2015a).

**Chart 5**
**Expenditures on industrial research and development in manufacturing, Canada and selected provinces**




**Sources:** Statistics Canada, CANSIM tables 358-0024 and 358-0161.

**Chart 6**
**Expenditures on industrial research and development in scientific research and development services, Canada and selected provinces**




**Sources:** Statistics Canada, CANSIM tables 358-0024 and 358-0161.

higher expenditures by aerospace companies helped the province maintain its share of total in-house R&D spending at 29.1%.

The intensity of R&D spending in different parts of the country has also changed in recent years. In 2007, Quebec's BERD-to-GDP ratio stood at 1.7%, while Ontario's was 1.4% (Chart 8). In both provinces, in-house R&D spending, as a percentage of nominal output produced, declined during the recession and continued to edge downward as the economy returned to growth. By 2013, Quebec's BERD-to-GDP ratio had fallen to 1.4% while Ontario's stood at 1.1%. Alberta's BERD-to-GDP ratio, 0.6% in 2007, did not decline during the recession, and stayed at 0.6% in 2013. In-house R&D expenditure in the province, supported by energy companies, generally kept pace with output gains during these years.

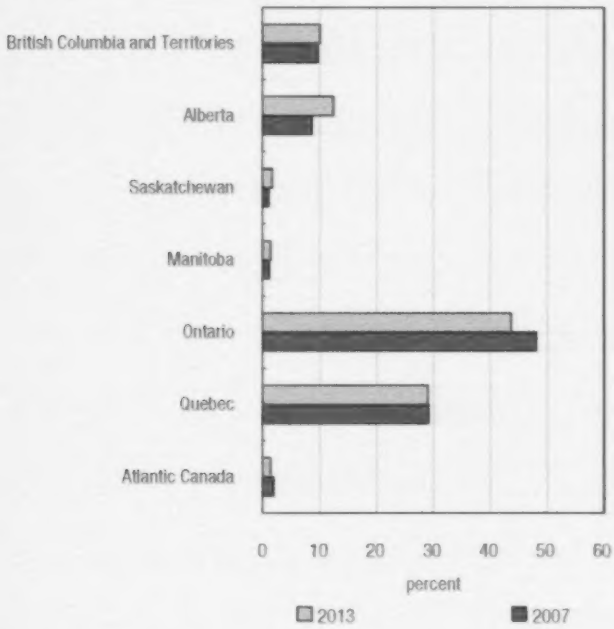
Table 1 presents more detailed industry-level data on changes in R&D intensity in Ontario, Quebec and Alberta for the 2007-to-2013 period.[17] For each province, this table reports BERD-to-GDP ratios for five industrial groups—manufacturing; professional, scientific and technical services; information and cultural industries; wholesale trade; and mining, quarrying, and oil and gas extraction. The share of provincial R&D expenditures accounted for by each of these industries as well as their share of nominal output are also reported.

Ontario-based manufacturing exhibited a BERD-to-GDP ratio of 5.4% in 2007. In that year, manufacturing companies accounted for about 60% of in-house R&D expenditures in Ontario, and manufacturing represented about 16% of the province's nominal output. In 2013, the BERD-to-GDP of Ontario manufacturers edged down to 4.2%, as the share of provincial R&D performed by these companies fell to about 50%; at the same time, manufacturing industries in Ontario accounted for a smaller share (12%) of provincial output. By contrast, the R&D share of professional, scientific and technical services in Ontario began rising before the recession. In 2013, the BERD-to-GDP ratio of these companies was 3.9%, and they accounted for just under one quarter of provincial R&D expenditures. Both measures are higher than in 2007.

The R&D intensity of Quebec-based manufacturers, supported by in-house R&D expenditure on aerospace, increased from 2009 to 2013, and was higher than it was prior to the recession when

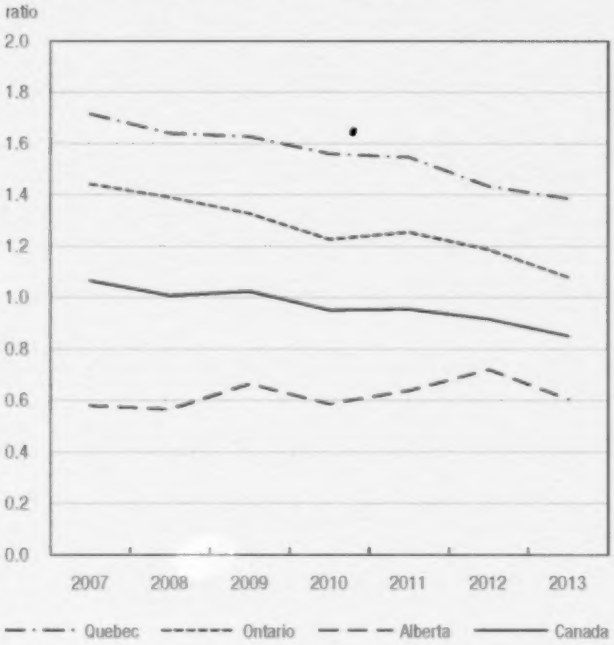
17. It should be noted that the R&D data for specific industries is compiled at the enterprise level, while the nominal GDP estimates by industry are establishment-based.

**Chart 7**
**Regional distribution of expenditures on industrial research and development, 2007 and 2013**



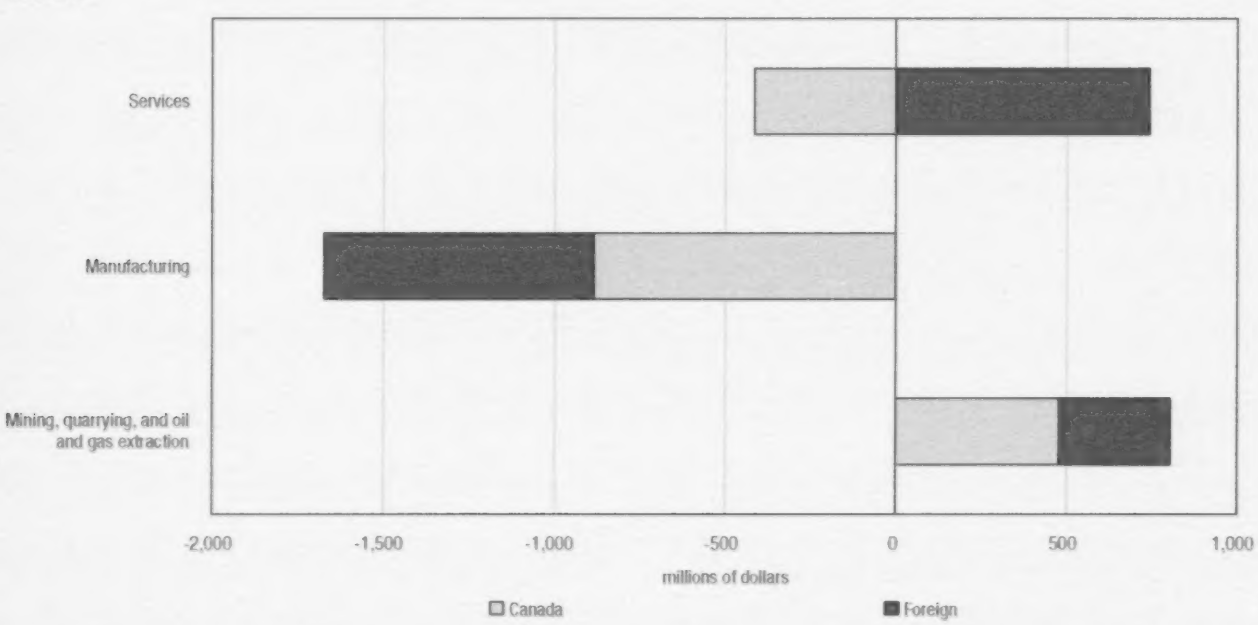

**Sources:** Statistics Canada, CANSIM table 358-0161.

**Chart 8**
**BERD-to-GDP ratio, Canada and selected provinces**




**Note:** BERD: business enterprise research and development; GDP: gross domestic product.
**Sources:** Statistics Canada, CANSIM tables 379-0030 and 358-0161; and OECD, n.d., *Main Science and Technology Indicators*, accessed from stats.oecd.org on November 4, 2016.

**Chart 9**
**Change in expenditures on industrial research and development in selected Canadian industries, by country of control, 2007 to 2013**




**Sources:** Statistics Canada, CANSIM table 358-0205.

**Table 1**
**Indicators for research and development and for output, selected provinces**

| Provinces and industries | BERD-to-GDP ratio | | | | | | | Industry share of industrial R&D | | | | | | | Industry share of nominal GDP | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
| | percent | | | | | | | | | | | | | | | | | | | | |
| **Quebec** | | | | | | | | | | | | | | | | | | | | | |
| Mining, quarrying, and oil and gas extraction | 0.5 | x | x | x | x | 0.4 | 1.0 | 0.3 | x | x | x | x | 0.5 | 1.1 | 1.0 | 1.2 | 0.9 | 1.5 | 1.8 | 1.5 | 1.5 |
| Manufacturing | 4.9 | 4.8 | 5.5 | 5.5 | 5.5 | 5.6 | 5.9 | 48.6 | 46.5 | 49.5 | 51.6 | 51.0 | 54.3 | 56.7 | 17.1 | 16.0 | 14.8 | 14.6 | 14.4 | 13.9 | 13.4 |
| Wholesale trade | 2.0 | 1.9 | 2.0 | 2.2 | 2.5 | 1.9 | 1.4 | 6.9 | 6.6 | 6.9 | 7.6 | 8.6 | 6.8 | 5.5 | 5.9 | 5.6 | 5.6 | 5.5 | 5.3 | 5.2 | 5.4 |
| Information and cultural industries | 3.5 | 3.6 | 3.0 | 3.1 | 2.3 | 2.5 | 2.5 | 7.0 | 7.3 | 6.1 | 6.4 | 4.8 | 5.7 | 5.6 | 3.4 | 3.3 | 3.3 | 3.3 | 3.2 | 3.3 | 3.1 |
| Professional, scientific and technical services | 7.8 | 8.0 | 8.0 | 7.0 | 7.3 | 6.0 | 5.7 | 22.9 | 26.1 | 27.2 | 25.1 | 27.3 | 25.0 | 24.5 | 5.1 | 5.3 | 5.5 | 5.5 | 5.8 | 5.9 | 6.0 |
| **Ontario** | | | | | | | | | | | | | | | | | | | | | |
| Mining, quarrying, and oil and gas extraction | 0.3 | 0.2 | 1.4 | 0.8 | 1.0 | 1.1 | 1.0 | 0.3 | 0.2 | 0.8 | 0.7 | 1.1 | 1.1 | 1.2 | 1.4 | 1.3 | 0.8 | 1.1 | 1.4 | 1.2 | 1.2 |
| Manufacturing | 5.4 | 5.4 | 5.9 | 4.9 | 5.0 | 4.6 | 4.2 | 59.5 | 54.2 | 57.2 | 50.9 | 49.9 | 49.2 | 47.3 | 16.0 | 14.0 | 12.8 | 12.9 | 12.6 | 12.8 | 12.2 |
| Wholesale trade | 1.2 | 2.6 | 2.2 | 2.0 | 1.9 | 2.0 | 2.0 | 5.3 | 11.1 | 9.9 | 10.4 | 9.9 | 11.1 | 12.0 | 6.2 | 6.0 | 6.0 | 6.3 | 6.4 | 6.5 | 6.4 |
| Information and cultural industries | 3.9 | 3.1 | 2.6 | 2.8 | 2.4 | 2.8 | 2.6 | 9.9 | 8.4 | 7.6 | 8.6 | 7.1 | 8.8 | 9.2 | 3.7 | 3.7 | 3.8 | 3.8 | 3.7 | 3.8 | 3.7 |
| Professional, scientific and technical services | 3.8 | 3.7 | 3.4 | 4.2 | 4.7 | 4.3 | 3.9 | 16.5 | 17.5 | 16.8 | 22.7 | 24.8 | 23.4 | 23.3 | 6.2 | 6.6 | 6.6 | 6.6 | 6.6 | 6.4 | 6.4 |
| **Alberta** | | | | | | | | | | | | | | | | | | | | | |
| Mining, quarrying, and oil and gas extraction | 0.8 | 0.6 | 0.9 | 0.8 | 1.3 | 2.0 | 1.4 | 39.9 | 36.6 | 30.6 | 32.4 | 52.7 | 62.4 | 53.8 | 28.2 | 32.1 | 22.1 | 24.7 | 25.5 | 22.7 | 23.8 |
| Manufacturing | 1.7 | 2.6 | 3.1 | 3.1 | 1.4 | 1.0 | 0.9 | 21.3 | 30.0 | 31.1 | 37.6 | 17.5 | 10.5 | 10.7 | 7.4 | 6.4 | 6.6 | 7.0 | 7.8 | 7.9 | 7.6 |
| Wholesale trade | 0.6 | 0.5 | 0.8 | 0.6 | 0.6 | 0.8 | 0.7 | 4.5 | 3.8 | 5.3 | 4.1 | 4.1 | 5.2 | 5.5 | 4.5 | 4.2 | 4.7 | 4.3 | 4.6 | 4.9 | 4.8 |
| Information and cultural industries | 0.7 | 1.1 | 1.2 | 1.2 | 1.5 | 1.4 | 1.2 | 2.8 | 4.5 | 5.0 | 5.4 | 5.8 | 4.6 | 4.3 | 2.5 | 2.3 | 2.7 | 2.5 | 2.4 | 2.3 | 2.1 |
| Professional, scientific and technical services | 1.8 | 1.6 | 1.5 | 1.5 | 1.5 | 1.3 | 1.4 | 15.9 | 14.2 | 13.4 | 13.8 | 12.6 | 10.3 | 13.4 | 5.1 | 4.9 | 5.8 | 5.5 | 5.4 | 5.8 | 5.7 |

x suppressed to meet the confidentiality requirements of the *Statistics Act*

**Note:** BERD: business enterprise research and development; GDP: gross domestic product; R&D: research and development.

**Sources:** Statistics Canada, CANSIM tables 379-0030 and 358-0161; and Statistics Canada, 2015b, Special tabulation for professional, scientific and technical services.

manufacturing accounted for a larger share of provincial output. In 2013, the BERD-to-GDP ratio of Quebec manufacturers was 5.9% and manufacturing companies accounted for 57% of R&D spending in the province.

In Alberta, higher energy in-house R&D expenditures contributed to the increase in the BERD-to-GDP ratio for the province's resource sector, up from 0.8% in 2007 to 1.4% in 2013, and the sector's share of provincial R&D spending from about 40% to 54%. Manufacturers and firms that provide professional, scientific and technical services in Alberta are less R&D-intensive than those located in central Canada.

## Foreign-controlled firms supported higher R&D spending in energy and scientific services

Since the 2008-2009 recession, investments by foreign-controlled firms supported the growth in science-based R&D services and resource-based R&D. Foreign-controlled firms can be more capital intensive and productive than Canadian-controlled firms, and are more likely to spend on R&D or introduce innovations (Baldwin and Gellatly 2007). From 2007 to 2013, in-house R&D spending by Canadian-controlled firms declined, while spending by foreign-controlled firms rose to roughly over one third of total expenditures. Higher expenditures by foreign-controlled firms, mainly from the United States, offset a portion of the decline in Canadian industrial R&D spending between 2007 and 2013.

Both Canadian and foreign-controlled firms decreased their in-house R&D spending on manufacturing and increased spending on resource extraction (Chart 9). In-house R&D expenditures by Canadian and foreign-controlled resource-based companies have both roughly doubled from 2007 to 2013. The overall share of R&D spending by foreign-controlled firms increased in resource-based industries and declined in manufacturing as foreign companies have divested out of manufacturing at a relatively faster pace than Canadian-controlled firms. The growth in science-based R&D services was also supported by foreign-controlled companies. From 2007 to 2013, foreign-controlled firms that provide R&D services more than doubled their spending, while Canadian-controlled firms reduced spending by 7.8%.

## Conclusion

This article highlights recent changes in the pace and composition of in-house spending on research and development by business enterprises from 2000 to 2013. Much of the support for higher R&D spending since the 2008-2009 recession has come from investments by Alberta-based energy companies, which accelerated their capital spending on structural assets and

machinery and equipment during the early part of this decade to support the growth in oil extraction.

Industrial R&D spending is an integral part of a country's innovation system. R&D expenditures are investments that firms make in the creation of new proprietary forms of knowledge—investments that, when they result in the commercialization of new products or more efficient production techniques, can be expected to bolster a firm's relative competitiveness. Firms allocate scarce resources towards activities that they expect to yield profitable returns. The aggregate data examined in this report highlight how the structure of Canadian industrial R&D has changed in recent years as overall investment spending has shifted towards energy-based companies. Changes in industrial R&D spending mirror these investment flows.

While the support for higher R&D came largely from resources, overall levels of R&D spending in the resource sector remained modest ($1.6 billion in 2013) when compared to total in-house R&D expenditures by manufacturers ($6.8 billion). During the 2008-2009 recession, R&D spending by Ontario-based manufacturers fell markedly, and has continued to decline in more recent years. Higher aerospace R&D spending in Quebec offset broad-based declines among other manufacturing industries in the province.

Canada's industrial R&D system has an international dimension, and recent changes in the pace of spending reflect this. Canadian-controlled firms were responsible for the overall decline in in-house R&D expenditures from 2007 to 2013, which reflected lower spending on manufacturing and services. Higher spending by foreign-controlled firms partly offset the downturn. R&D activity by foreign-controlled firms increased in recent years, as foreign-controlled companies divested out of manufacturing and increased spending in services and resources.

# References

Baldwin, J.R. and G. Gellatly. 2007. *Global Links: Multinationals in Canada: An Overview of Research at Statistics Canada.* The Canadian Economy in Transition, no. 14. Statistics Canada Catalogue no. 11-622-M. Ottawa: Statistics Canada.

Bloskie, C., V. Gaudreault, and G. Gellatly. 2013. *Changes in the composition of aggregate investment.* Economic Insights, no. 22. Statistics Canada Catalogue no. 11-626-X. Ottawa: Statistics Canada.

Brown, W.M. 2014. *Testing for Provincial Industrial Structural Change through the 2000s.* Economic Analysis Research Paper Series, no. 92. Statistics Canada Catalogue no. 11F0027M. Ottawa: Statistics Canada.

Council of Canadian Academies. 2013. *The State of Industrial R&D in Canada.* Ottawa, Ontario: The Expert Panel on the State of Industrial R&D in Canada, Council of Canadian Academies.

Gaudreault, V., G. Gellatly, and C. Bloskie. 2015. *Non-residential capital expenditures: 2014 preliminary actual estimates and 2015 intentions.* Economic Insights, no. 48. Statistics Canada Catalogue no. 11-626-X. Ottawa: Statistics Canada.

Lotimo, C. 2007. *Innovators, Non-innovators and Venture Firms: What Is the Nature of Firms in Research and Development Services Industries?* Business Special Surveys and Technology Statistics Division Working Papers, no. 7. Statistics Canada Catalogue no. 88F0006XIE. Ottawa: Statistics Canada.

Macdonald, R. 2014. *Business Entry and Exit Rates in Canada: A 30-year Perspective.* Economic Insights, no. 38. Statistics Canada Catalogue no. 11-626-X. Ottawa: Statistics Canada.

OECD (Organisation for Economic Co-operation and Development). n.d. *Main Science and Technology Indicators.* Available at: https://stats.oecd.org/Index.aspx?DataSetCode=MSTI_PUB (accessed on November 4, 2016).

Statistics Canada. n.d.a. *Table 380-0100 Contributions to percent change in real gross domestic product, expenditure-based, annual (percent)* (table). CANSIM (database). Last updated May 30, 2016. Available at: http://www5.statcan.gc.ca/cansim/a26?lang=eng&id=3800100&p2=17 (accessed October 26, 2016).

Statistics Canada. n.d.b. *Table 379-0030 Gross domestic product (GDP) at basic prices, by North American Industry Classification System (NAICS), provinces and territories, annual (dollars) (table).* CANSIM (database). Last updated May 11, 2016. Available at: http://www5.statcan.gc.ca/cansim/a26?lang=eng&id=3790030&p2=17 (accessed October 26, 2016).

Statistics Canada. n.d.c. *Table 527-0007 Business dynamics measures, by North American Industry Classification System (NAICS), provinces and the territories, annual (number unless otherwise noted) (table).* CANSIM (database). Last updated: September 23, 2016. Available at: http://www5.statcan.gc.ca/cansim/a26?lang=eng&id=5270007&p2=17 (accessed October 26, 2016).

Statistics Canada. 2015a. *Industrial Research and Development: Intentions.* Statistics Canada Catalogue no. 88-202-X. Ottawa: Statistics Canada. Available at: http://www.statcan.gc.ca/pub/88-202-x/88-202-x2015000-eng.htm (accessed November 8, 2016).

Statistics Canada. 2015b. Special tabulation for professional, scientific and technical services, based on the Annual Survey of Research and Development in Canadian Industry. Produced by the Investment, Science and Technology Division.